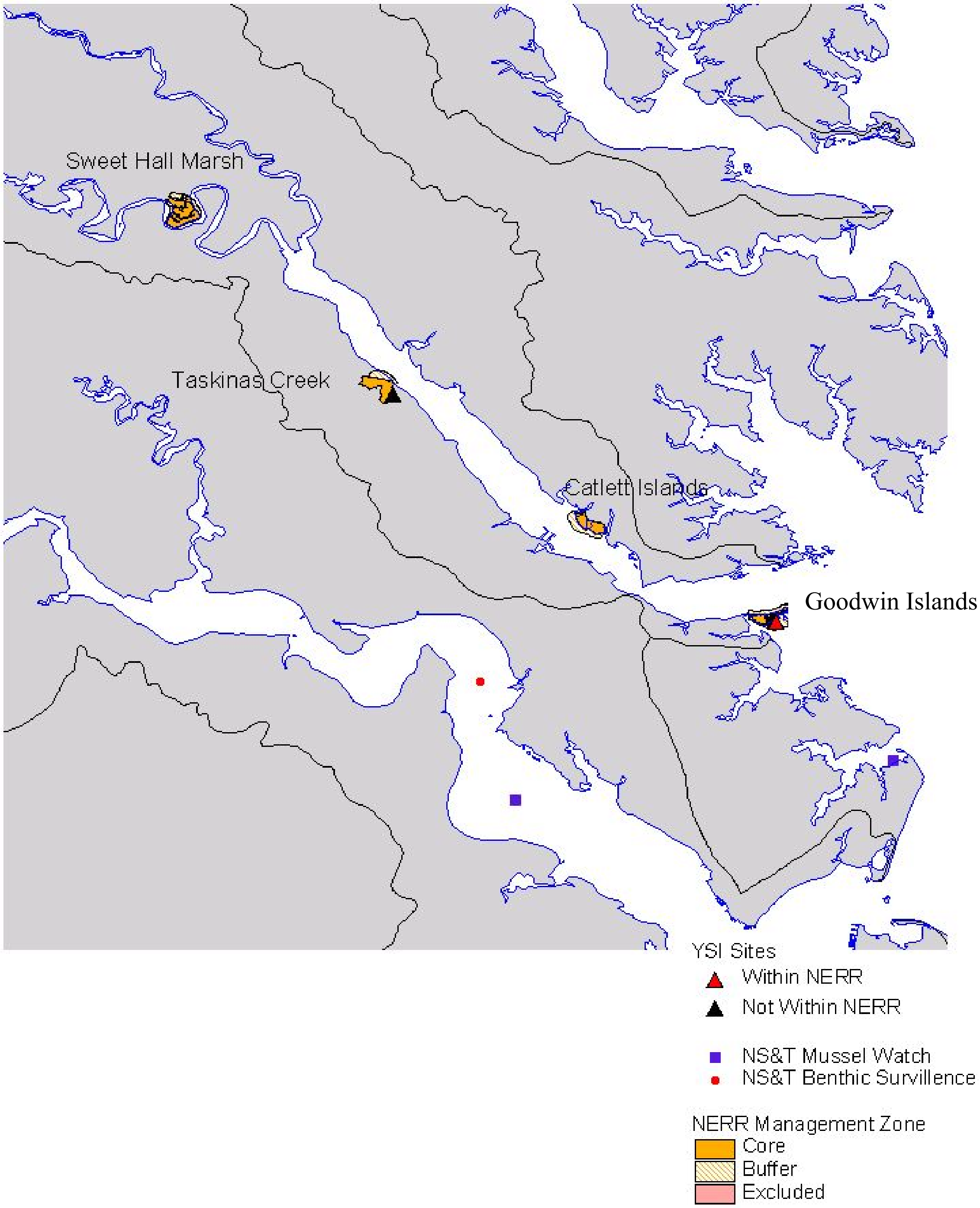
Chesapeake Bay, VA



Chesapeake Bay Virginia, Goodwin Islands (CBVGI)

Characterization (Latitude = 37° 13' 00"N; Longitude = 76° 23' 37"W)
The Goodwin Islands component of the CBNERR-VA is on the mouth of the York River at the northeastern tip of York County. Circulation patterns at the Goodwin Islands are influenced by York River discharge and the wind patterns of the Chesapeake Bay. The Goodwin Islands represent relatively pristine marsh islands surrounded by inter-tidal flats, submerged aquatic vegetation (SAV) beds, a single constructed oyster reef, and shallow open estuarine waters. Dominant marsh species include Saltmarsh Cordgrass (*Spartina alterniflora*), Salt Grass (*Distichlis spicata*), and Saltmeadow Hay (*Spartina patens*). Forested wetland ridges are dominated by estuarine scrub/shrub vegetation with upland ridges dominated by mixed oak and pine communities. The sampling station is located in a shallow embayment on the southeastern side of the main island. The station is located approximately 400 m from shore, average water depth on the order of 1 m, amongst submerged aquatic vegetation beds dominated by eelgrass (*Zostera marina*) and Widgeon grass (*Ruppia maritima*). Tides are semi-diurnal and range from 0.4-1.1 m (average 0.67m). Sub-tidal substrate is dominated by sand. Potential activities that could impact the site include light recreational and commercial boating and recreational and commercial fishing.

Descriptive Statistics
Thirty-seven deployments were made at this site between October 1997 and December 1998, with equal coverage in all seasons (Figure 93). Mean deployment duration was 11.6 days. Only one deployment (Sep 1998) was slightly (4.9 days) less than 5 days.

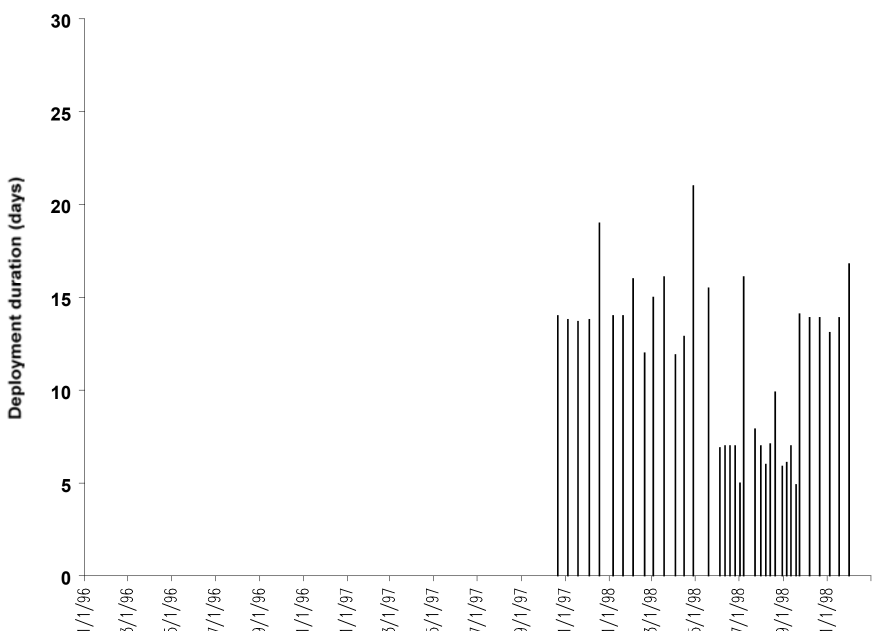


Figure 93. Chesapeake Bay VA, Goodwin Islands deployments (1996-1998).

Ninety-seven percent of annual depth data in 1997 and 19% of annual depth data in 1998 were included in analyses; no data were collected in 1996. Sensors were deployed at a mean depth of 0.6 m below the water surface and 0.5 m above the bottom sediment. Moderate fluctuation (0.5-1 m) in water depth was evident for daily and bi-weekly cycles from scatter plots. Harmonic regression analysis attributed 65% of depth variance to 12.42 hour cycles, 14% of depth variance to 24 hour cycles, and 21% of depth variance to interaction between 12.42 hour and 24 hour cycles.

Ninety-seven percent of annual water temperature data in 1997 and 19% of annual temperature data in 1998 were included in analyses; no data were collected in 1996. Water temperature followed a seasonal cycle between Oct 1997 and Dec 1998, with mean water temperature 7°C in winter and 27°C in summer (Figure 94). Minimum and maximum water temperatures recorded between Oct 1997 and Dec 1998 were 2.3°C (Jan 1998) and 31.6°C (Jul 1998), respectively. Scatter plots suggest strong fluctuation (1-3°C) in water temperature over daily cycles and even stronger fluctuation (≥5°C) in water temperature at bi-weekly intervals. Water temperature gradually warmed throughout the day. Harmonic regression analysis attributed 55% of temperature variance to interaction between 12.42 hour and 24 hour cycles, 34% of temperature variance to 24 hour cycles, and 11% of temperature variance to 12.42 hour cycles.

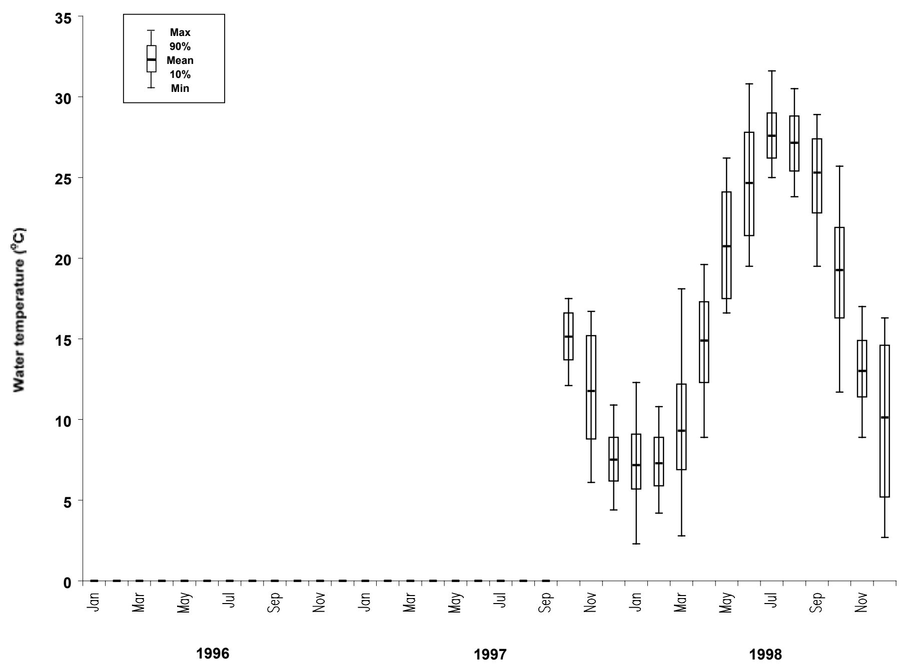


Figure 94. Water temperature statistics at Goodwin Island, 1996-1998.

Ninety-seven percent of annual salinity data in 1997 and 19% of annual salinity data in 1998 were included in analyses; no data were collected in 1996. Salinity followed a well-defined seasonal cycle between Oct 1997 and Dec 1998. Mean salinity was greatest (23-25 ppt) in summer and fall and least (13-15 ppt) in winter and spring (Figure 95). Salinity range between Oct 1997 and Dec 1998 was moderate, with minimum salinity of only 9.9 ppt (Jan 1998) and maximum salinity of 27.5 ppt (Nov 1998). Fluctuations in salinity at daily and bi-weekly cycles were minor (1-3 ppt) in comparison with seasonal fluctuations in salinity. Harmonic regression analysis attributed 49% of salinity variance to interaction between 12.42 hour and 24 hour cycles, 33% of salinity variance to 24 hour cycles, and 18% of salinity variance to 12.42 hour cycles.

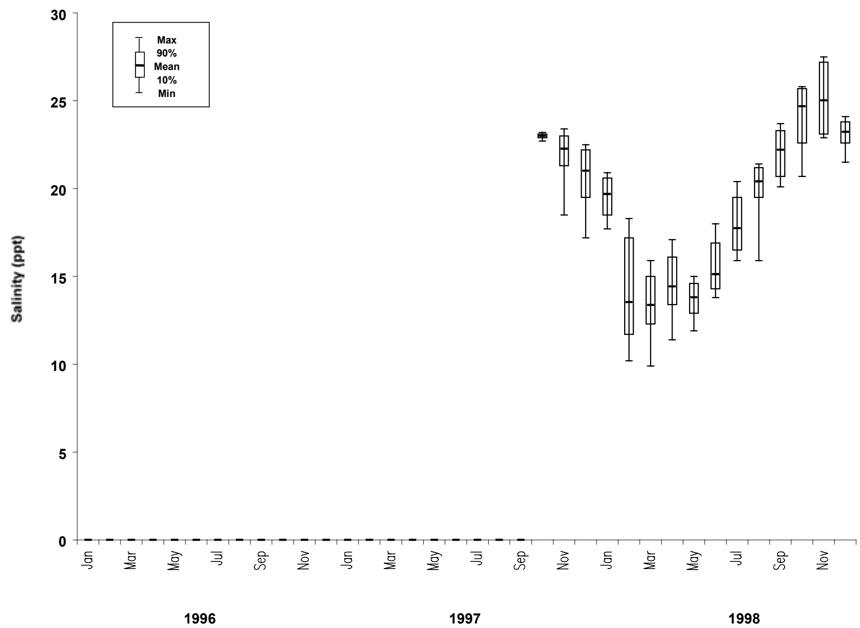


Figure 95. Salinity statistics at Goodwin Islands, 1996-1998.

Ninety-one percent of annual dissolved oxygen (% saturation) data were included in analyses (74% in 1997 and 95% in 1998). Mean dissolved oxygen readings were ≥100% saturation between Oct 1997 and Dec 1998, except for Jul-Aug 1998. Minimum and maximum DO readings were 23.6% (Oct 1998) and 195.7% (May 1998), respectively. Hypoxia was only observed in Oct 1998 and persisted for 1% of the first 48 hours post-deployment (Figure 96). Supersaturation was regularly observed and, when present, supersaturation persisted for 19.5% of the first 48 hours post-deployment on average. Scatter plots revealed DO fluctuations of 40-100% at daily and bi-weekly intervals, except for Jan-Feb 1998 when DO fluctuated by 20-40%. Harmonic regression analysis attributed 69% of DO variance to interaction between 12.42 hour and 24 hour cycles, 28% of DO variance to 24 hour cycles, and 3% of DO variance to 12.42 hour cycles.

Photosynthesis/Respiration

Nearly all (95%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 24). Instrument drift during the duration of the deployments was not a significant problem at this site. Gross production exceeded total respiration at Goodwin Islands; thus, the net ecosystem metabolism and P/R ratio indicated that this is an autotrophic site, one of the few in the Reserve system (Figure 97). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperatures increased. Salinity was significantly ($p<0.05$) negatively correlated with gross production and total respiration but not net ecosystem metabolism. Gross production and respiration were higher at lower salinity. Thus, the metabolic rates strongly followed a seasonal pattern with the highest rates during summer months and the lowest rates during winter when temperature and salinity were low and river flow was high.

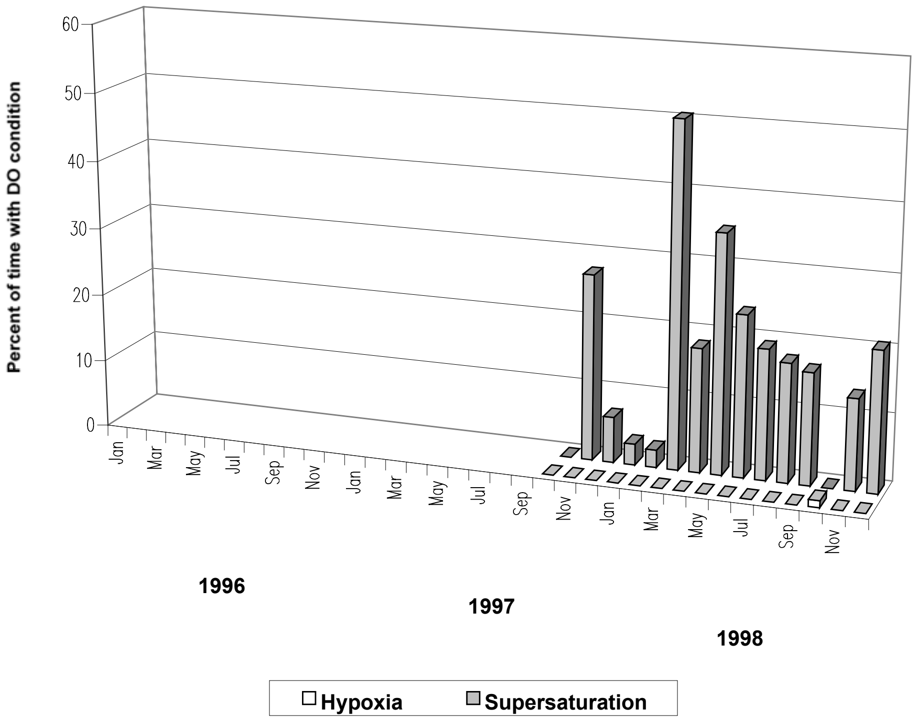


Figure 96. Dissolved oxygen extremes at Goodwin Islands, 1996-1998.

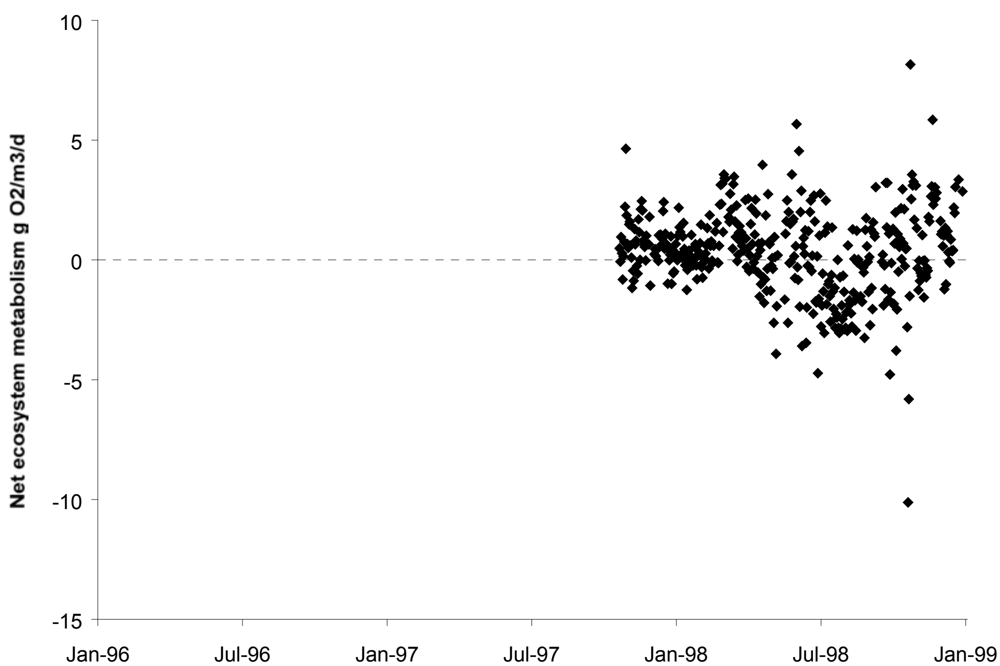


Figure 97. Net metabolism at Goodwin Islands, 1996-1998.

Table 24. Summary of metabolism data and statistics at Goodwin Islands, 1996-1998.

Goodwin Island	mean	s.e.
Water depth (m)	1.0	
Net production $gO_2/m3/d$	2.33	0.09
Gross production $gO_2/m3/d$	4.68	0.16
Total respiration $gO_2/m3/d$	4.37	0.18
Net ecosystem metabolism g $O_2/m3/d$	0.31	0.09
Net ecosystem metabolism g C/m2/y	203	
P/R	1.07	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	95%	
Paired t-test on gross production and total respiration	p<.0001	
Correlation coefficient	Temperature	Salinity
Gross production	0.64	-0.16
Total respiration	0.67	-0.19
Net ecosystem metabolism	-0.68	ns

Chesapeake Bay Virginia, Taskinas Creek (CBVTC)

Characterization (Latitude = 37° 24' 24"N; Longitude = 76° 42' 52")

The Taskinas Creek watershed is representative of an inner coastal plain rural watershed within the southern Chesapeake Bay system. Taskinas Creek is approximately 3 km in length and flows in a northeasterly direction eventually emptying into the York River. This watershed is dominated by forested and agricultural land uses with an increasing urban land use component. The non-tidal portion of Taskinas Creek contains feeder streams, which drain oak-hickory forests, maple-gum-oak-ash swamps and freshwater marshes. Dominant low tidal creek marsh species include Saltmarsh cordgrass (*Spartina alterniflora*), Salt Grass (*Distichlis spicata*), and Saltmeadow Hay (*Spartina patens*) at the creek mouth. Three-square (*Scirpus americanus* and *S. olneyi*) and Big Cordgrass (*Spartina cynosauroides*) characterize the middle marsh reaches and freshwater mixed (no single species covers more than 50%) wetlands in the upstream reaches. The data logger station is located near the mouth of Taskinas Creek in the lower tidal creek bank region. Water depth and width are roughly 2 m and 20 m, respectively. Tides are semi-diurnal and range from 0.4-1.2 m (average 0.85 m). Sub-tidal substrate is primarily fine sediments (42% fine sand, 30% clay, and 28% silt). Potential activities that impact the site include residential development, selective hardwood logging, and light recreational boating activity. Wildlife populations are known to influence microbiological water quality within the watershed.

Descriptive Statistics
Seventy-one deployments were made at this site between Jan 1996 and Dec 1998 (Figure 98). Equal coverage was provided in all seasons; however, deployment duration was greater (≥ 20 days) between Nov 1996 and Aug 1998 (with two exceptions) than the rest of the study. Mean deployment duration was 13.8 days. Only two deployments (Apr 1997, Aug 1998) were less than five days.

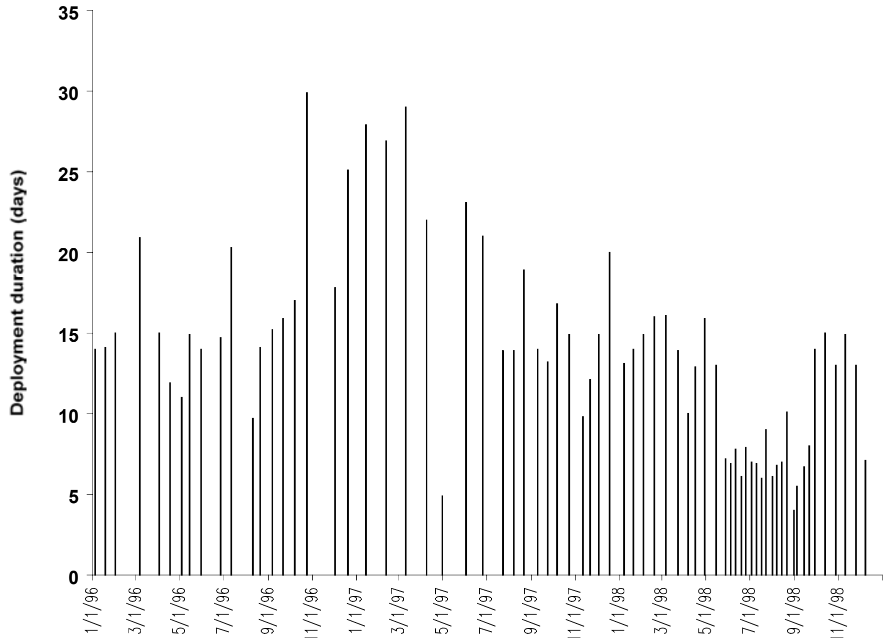


Figure 98. Chesapeake Bay VA, Taskinas Creek deployments (1996-1998).

Eighty-seven percent of annual depth data were included in analyses (72% in 1996, 91% in 1997, and 98% in 1998). Sensors were deployed at a mean depth of 0.9 m below the water surface and 0.5 m above the bottom sediment. Moderate fluctuation (0.5-1 m) in water depth was evident at daily and bi-weekly intervals from scatter plots, with consistent amplitude throughout the data. Harmonic regression analysis attributed 92% of depth variance to 12.42 hour cycles and 4% of depth variance to both 24 hour cycles and interaction between 12.42 hour and 24 hour cycles.

Ninety percent of annual water temperature data were included in analyses (80% in 1996, 96% in 1997, and 95% in 1998). Water temperature followed a seasonal cycle, with mean water temperature 26-28°C in summer in all three years (Figure 99). Mean winter water temperature in 1997 and 1998 was 5-7°C, compared to a mean winter water temperature of 2°C in 1996. Minimum and maximum water temperatures recorded between 1996 and 1998 were -0.7°C (Jan 1996) and 35.1°C (Jul 1998), respectively. Scatter plots suggest strong fluctuations (2-4°C) in daily water temperature and even stronger fluctuations (5-10°C) in bi-weekly water temperature. Water temperature was lowest at night and increased, sometimes abruptly, throughout the day. Amplitude of bi-weekly fluctuations remained fairly constant on a seasonal basis. Harmonic regression analysis attributed 61% of temperature variance to 24 hour cycles, 29% of temperature variance to interaction between 12.42 hour and 24 hour cycles, and 10% of temperature variance to 12.42 hour cycles.

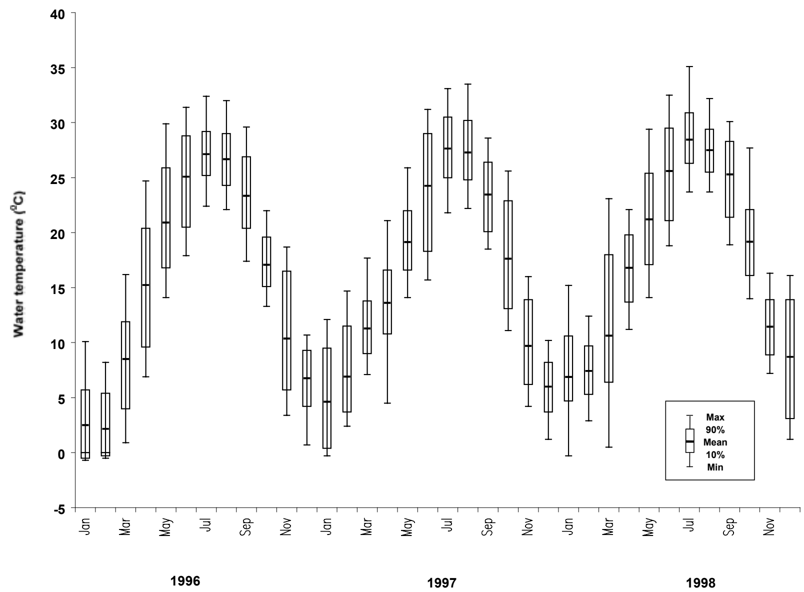


Figure 99. Water temperature statistics for Taskinas Creek, 1996-1998.

Eighty-six percent of annual salinity data were included in analyses (76% in 1996, 88% in 1997, and 95% in 1998). Salinity followed a seasonal cycle in 1997 and 1998, but seasonal variation in salinity was not evident in 1996 (Figure 100). Mean salinity in summer 1997 and 1998 was 14-16 ppt and mean salinity in winter 1997 and 1998 was 3-5 ppt. In 1996, mean salinity only varied between 6-10 ppt. Minimum and maximum salinity recorded between 1996-1998 was 0.1 ppt (Mar 1996) and 20.3 ppt (Nov 1998), respectively. Scatter plots suggest strong fluctuation (5-10 ppt) in salinity at both daily and bi-weekly intervals that were almost equivalent to seasonal variation in salinity. Harmonic regression analysis attributed 89% of salinity variance to 12.42 hour cycles, 7% of salinity variance to interaction between 12.42 hour and 24 hour cycles, and 4% of salinity variance to 24 hour cycles.

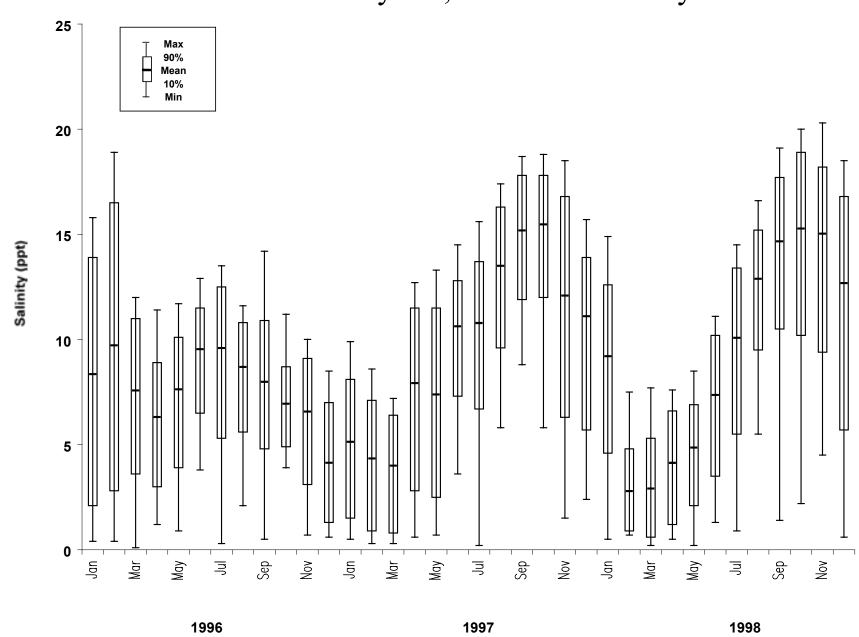


Figure 100. Salinity statistics for Taskinas Creek, 1996-1998.

Seventy-six percent of annual dissolved oxygen (% saturation) data were included in analyses (71% in 1996, 70% in 1997, and 88% in 1998). Mean DO below 50% saturation was only observed in two months (Jul 1996, Jun 1997) and mean DO above 100% saturation was also only observed in two months (Feb, Mar 1996). Mean DO was lowest in the summer and greatest in winter. Minimum and maximum DO observed between 1996-1998 was 0% saturation (Jun 1997) and 239% saturation (May 1996), respectively. Hypoxia was rarely observed and when present, lasted less than 2% of the first 48 hours post-deployment on average (Figure 101). Supersaturation was frequently observed, and when present lasted an average of 14% of the first 48 hours post-deployment. Scatter plots indicated fluctuations in percent saturation was greatest in spring and summer (60-120%) and least in fall and winter (20-60%) at both daily and bi-weekly intervals. Harmonic regression attributed 40% of DO variance to 12.42 hour cycles, 39% of DO variance to interaction between 12.42 hour and 24 hour cycles, and 21% of DO variance to 24 hour cycles.

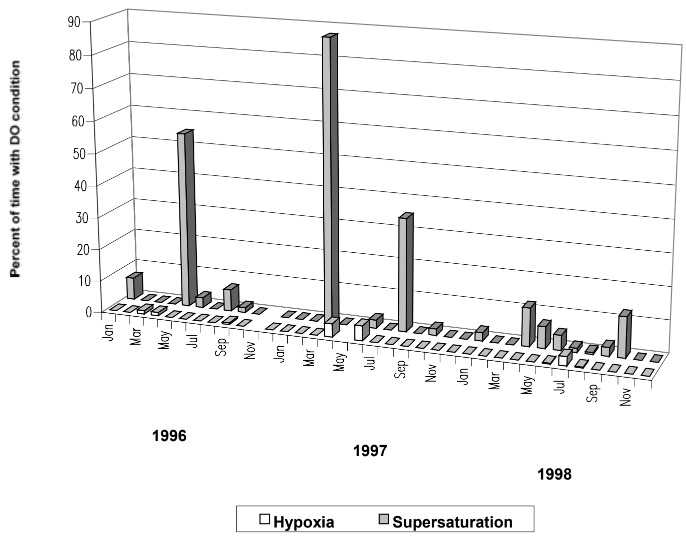


Figure 101. Dissolved oxygen extremes at Taskinas Creek, 1996-1998.

Photosynthesis/Respiration

Over four fifths (83%) of the data used to calculate the metabolic rates fit the basic assumption of the method (heterogeneity of water masses moving past the sensor) and were used to estimate net production, gross production, total respiration and net ecosystem metabolism (Table 25). Instrument drift during the duration of the deployments was not a significant problem at this site. Total respiration exceeded gross production at Taskinas Creek; thus, the net ecosystem metabolism and P/R ratio indicated that this is a heterotrophic site (Figure 102). Temperature was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration increased as temperature increased, while net ecosystem metabolism became more heterotrophic as temperatures increased. Salinity was significantly ($p<0.05$) correlated with gross production, total respiration and net ecosystem metabolism. Gross production and respiration were higher at higher salinity and net ecosystem metabolism became more heterotrophic at higher salinity. Metabolic rates strongly followed a seasonal pattern, with highest rates during summer months and lowest rates during winter when temperature and salinity were low and river flow was high.

Table 25. Summary of metabolism data and statistics at Taskinas Creek, 1996-1998.

Taskinas Creek	mean	s.e.
Water depth (m)	2.0	
Net production $gO_2/m3/d$	1.06	0.07
Gross production $gO_2/m3/d$	3.67	0.12
Total respiration $gO_2/m3/d$	4.78	0.14
Net ecosystem metabolism g $O_2/m3/d$	-1.11	0.07
Net ecosystem metabolism g C/m2/y	-54	
P/R	0.77	
Statistical results		
Drift – paired t-test		
Gross production	ns	
Total respiration	ns	
Net ecosystem metabolism	ns	
Percent useable observations	83%	
Paired t-test on gross production and total respiration	$p<0.001$	
Correlation coefficient	Temperature	Salinity
Gross production	0.52	0.13
Total respiration	0.65	0.16
Net ecosystem metabolism	-0.38	-0.10

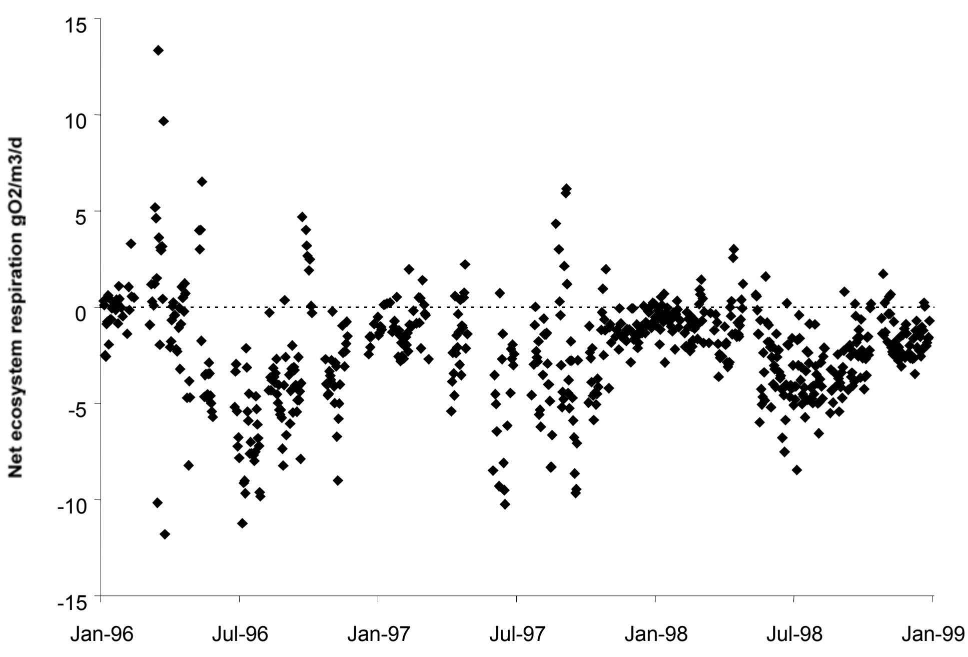


Figure 102. Net metabolism at Taskinas Creek, 1996-1998.